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DDT Levels in Milk of Rural Indigent Blacks

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16. ABSTRACT

Human milk samples from low-income blacks residing in rural Mississippi and Arkansas and middle-class whites residing in metrolopitan Nashville, Tennessee, were analyzed for DDT and its metabolites. The mean total DDT (DDE + DDT) whole milk concentration of 38 samples from indigent blacks between April and September, 1974 was 447 ppb (range 59 to 1900 ppb) and the mean of the 14 samples from Nashvillians during the same period was 75 ppb (range 15 to 133 ppb). Seven samples from the black population in June-September 1975 contained a mean total DDT of 323 ppb (range 185-721 ppb).

This statistically significant difference in the DDT concentrations in the black and white populations indicates that the indigent blacks are still highly contaminated with pesticides even though the general use of DDT has been banned. Due to the limited amount of information from the donors, no correlation could be made between the DDT concentration and any factors other than race or socioeconomic group.

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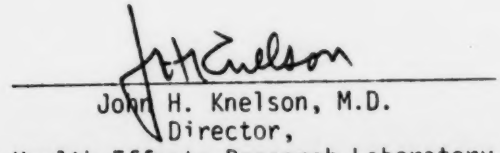
FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory develops and revises air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is preparing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

Although the general use of DDT has been removed in the United States, residues of this previously used and widely distributed pesticide persist in the environment. This study was undertaken in an effort to assess the level of contamination of humans in a previously high-use area and to attempt to assess the potential for adverse human health effects.



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ABSTRACT

Human milk samples from low-income blacks residing in rural Mississippi and Arkansas and middle-class whites residing in metropolitan Nashville, Tennessee, were analyzed for DDT and its metabolites. The mean total DDT (DDE + DDT) whole milk concentration of 38 samples from indigent blacks between April and September, 1974 was 447 ppb (range 59 to 1900 ppb) and the mean of the 14 samples from Nashvillians during the same period was 75 ppb (range 15 to 133 ppb). Seven samples from the black population in June-September 1975 contained a mean total DDT of 323 ppb (range 185-721 ppb).

This statistically significant difference in the DDT concentrations in the black and white populations indicates that the indigent blacks are still highly contaminated with pesticides even though the general use of DDT has been banned. Due to the limited amount of information from the donors, no correlation could be made between the DDT concentration and any factors other than race or socioeconomic group.

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SECTION I

CONCLUSIONS

The total DDT (DDT + DDE) levels in the milk of low income rural black women in cotton-growing areas were found to be six times higher than those found in middle class urban whites. The mean total DDT level for the blacks (38 samples) in 1974 was 447 ppb (range 59 to 1900) in the whole milk; for the whites in the same period it was 75 ppb (range 15 to 133). Seven samples from the blacks taken in 1975 yielded a mean of 323 ppb (range 185 to 721).

These results indicate that low-income rural blacks in cotton growing areas are still highly contaminated with DDT and its metabolites, although apparently the levels are now decreasing. Due to the failure of most of the donors to complete a questionnaire, no correlation could be made between the DDT concentration and diet, age of child, home pesticide use, or distance of residence from fields.

SECTION II

RECOMMENDATIONS

Although the general use of DDT has been banned,[32] this study indicates a population that is obviously still highly contaminated with pesticides. It is necessary to reiterate here that we have found no reported cases in the literature of breast-fed infants being harmed by the DDT, but these low income blacks from agricultural areas appear to be the population to study to determine if infants are in fact harmed by the DDT in human milk. We urge other researchers to systematically study this group of women (whose milk contained an average DDT concentration of almost a factor of ten greater than the WHO limit for cow's milk) and attempt to determine if in fact infants are affected by DDT in human milk. Our results alone, without such clinical studies, can not be used to justify either more or less stringent regulation of the use of DDT, nor do they justify advising these black mothers not to nurse their infants. Our results do justify, however, clinical study of these infants which are being exposed to quantities of DDT greatly in excess of the maximum admissible limit recommended by the World Health Organization.

SECTION III

INTRODUCTION

The concentrations of DDT and its metabolites in human milk have been of interest not only to mothers planning to breast feed their infants but also to the general public.[1] Table I summarizes the DDT concentrations found in human milk by researchers the world over. The results presented in Table I indicate that human milk generally contains DDT concentrations in excess of the maximum set for cow's milk (50 ppb) by the WHO;[27] the medical significance of this is unknown.

The scientific and medical literature contains no confirmed cases of infants suffering damage from the DDT in milk, but Fahim and coworkers[28] have reported increased mortality of nursing rats whose mothers were fed DDT. Hayes,[29] on the other hand, reported that adult humans given oral DDT doses 550 times greater than the average daily intake for 21.5 months showed no definite clinical or laboratory evidence of damage for the five years over which they were examined. Any damage to the human might well be expected to be found in the susceptible infant rather than the adult, however.

Many low-income black families in the rural southern and southeastern United States are exposed to somewhat different environmental factors than other Americans. On numerous occasions, workers have been seen chopping cotton in fields while the crop was being sprayed or dusted with pesticides from airplanes. Many of the homes inhabited by these black families are located within the confines of cotton fields which are sprayed. Windows, doors, and cracks in the walls of these homes presumably allow the spray to spread within the dwelling, where both food and water may be contaminated.

In 1970 alone, nearly a billion pounds of some 900 registered pesticides were applied (more than 50 percent for farm use) throughout the United States.[30] Although regional statistics are unavailable, a 1964 survey by the U.S. Department of Agriculture indicated that the cotton market accounted for 70 percent of the DDT used on farms.[31] Even though a ban on the general use of DDT took effect on January 1, 1973,[32] a persistent pesticide such as DDT would not immediately be removed from the environment.

Blacks in rural poverty areas of the South who have been exposed to high pesticide concentrations for years would be expected to store above average amounts of DDT and its metabolites in the adipose tissue due to the high solubility of these compounds in fats and their relative insolubility in aqueous solutions. Since DDT and its metabolites are excreted in the milk, infants nursing black mothers residing in these areas would be logical

TABLE I SUMMARY OF DDT CONCENTRATION IN HUMAN MILK

Locale	Number of samples	Range total DDT[a] (ppm)	Mean total DDT[a] (ppm)	Range DDT[b] (ppm)	Mean DDT[b] (ppm)	Range DDE[c] (ppm)	Mean DDE[c] (ppm)	Date	Ref.
Australia	45	0.015-0.177	0.064					1973	2
Australia (urban)	20	.063- .956	.228					1973	3
Australia (rural)	20		.415					1973	3
Belgium	20		.119		0.047		0.072	1969	4
Canada	147		.139		.032		.097	1972	5
East Germany	96				.09		.21	1973	6
Germany	43		.112		.031		.081	1970	7
Hungary	10	.13 - .26						1964	8
Italy			.25		.10		.15	1970	9
Netherlands	50		.048		.016		.03	1971	10
New Guinea (remote)	55			0.000-0.179	.016	0.000-0.104	.007	1972	11
New Guinea (exposed)	19			.012- .627	.189[d]	.005- .409	.096[d]	1972	11
Poland					.20[d]		.30[d]	1968	12
Poland					.14		.22[d]	1970	12
Rumania	100		.530[d]		.253[d]		.277[d]	1969	13
Sweden	22		.107		.040		.066	1970	14
United Kingdom	19	.075- .170	.13	.030- .075		.040- .110		1965	15
Ukrainian SSR	366				.09		.14	1970	16
USSR	293				.097		.101	1970	17
Yugoslavia			.207		.094		.102	1970	18
Arizona, USA	6	.10 - .50						1973	19
California, USA	6	.0 - .37		.0 - .12		.0 - .25		1964	20
Colorado, USA	40			.01 - .11		.02 - .39		1973	21
Georgia, USA	5	.04 - .16	.07					1969	22
Pennsylvania, USA	53	.02 - .26	.09		.02		.07	1972	23
Washington, D.C., USA	32	.0 - .77	.13					1951	24
3 cities, USA	10	<.02 - .36	.12					1965	25
7 cities, USA	138	.02 - .83	.17					1973	26

[a] [b] ortho and para isomers of DDE and DDT.
[c] primarily PP' DDT, but OP' DDT included if given.
[d] primarily PP' DDE, but OP' DDE included if given.
concentrations were determined colorimetrically.

candidates for pesticide related damage. Preliminary data on the DDT concentration in human milk from women residing in these areas are here compared with data of DDT concentrations in milk from women residing in less exposed surburban areas.

SECTION IV

METHODS AND MATERIALS

Samples of human milk were obtained from black donors from rural poverty areas in Bolivar County, Mississippi, and Lee County, Arkansas. Samples were obtained during the period from April, 1974, through September, 1974, and from June to September, 1975. Samples were also collected during the earlier period from white, urban, middle-class donors residing in metropolitan Nashville, Tennessee. Donors were asked to complete a brief questionnaire regarding their exposure to pesticides, their food habits, and their weight gain or loss. Samples were kept frozen in polyethylene bags or in glass bottles until analysis.

DDT and its metabolites were extracted from the samples by slightly modifying the method recommended by the Primate and Pesticides Effects Laboratory, Environmental Protection Agency, Research Triangle Park, North Carolina.[33] One milliliter of the milk sample (spiked with 5 ng of aldrin) was extracted three times with 2.5 ml of acetonitrile in a tissue grinder. The acetonitrile was added to 25 ml of 2% aqueous sodium sulfate and extracted 3 times with 3 ml of hexane. The hexane extract was concentrated to 0.3 ml and then fractionated on a Florisil column. The first fraction was eluted by adding 12 ml of hexane followed by 12 ml of 1% methanol in hexane. The second fraction was eluted with another addition of 12 ml of 1% methanol in hexane. Each fraction was concentrated to 500 µl for injection into the gas chromatograph in a few runs; because of the small (less than 10 ppb) quantities of DDD found, the second fraction was generally discarded.

The concentrations of DDT and its metabolites were determined with an F & M 700 gas chromatograph which was equipped with a Tracor nickel-63 high-temperature electron capture detector. Pesticide separation was accomplished on a 6' x ¼" o.d. glass column packed with 1.5% OV-17/1.95% QF-1 on acid-washed, DMCS treated, 80/100 mesh Chromosorb W. Pesticide identification was verified on another column packed with 4% SE-30/6% OV-210 on Chromosorb W; mass spectral analysis for absolutely positive identification was not available. The following conditions were used during pesticide quantitation: volume of injection, 5µl; column temperature, 200°C; column nitrogen flow rate, 60 ml/min; detector purge flow rate, 20 ml/min.

Standards were prepared from pesticides received from the Primate and Pesticide Effects Laboratory using the method suggested by them.[33] Working standards were prepared in hexane and contained a mixture of aldrin and the isomers of DDE, DDD and DDT.

One standard used contained 10 ng/ml aldrin, 20 ng/ml op'DDE and pp'DDE, and 40 ng/ml op'DDD, pp'DDD, op'DDT and pp'DDT. A second standard contained half the concentration of each of these compounds. Samples with excessively high pesticide concentrations on the first analysis were diluted quantitatively with hexane so that a 5 µl injection would deliver a quantity of each pesticide that would be less than that contained in the more concentrated standard. The samples were analyzed by injecting one of the standards and then running four samples; this was followed by injecting the remaining standard. Each pesticide concentration was determined by measuring peak heights and then interpolating between the peak heights of the standards run on either side of the sample. The limit of detection of this method was found to be 0.5 ppb aldrin, 1.0 ppb DDE and 2.0 ppb DDD and DDT in the milk.

Analyses of distilled water samples established that reagents were not introducing spurious results. Preliminary studies using commercial cow's milk indicated that the pesticide levels present were below the detection limit of the method. Eight samples of fresh cow's milk were spiked with the pesticides of interest and analyzed using the same method as for human milk samples to check the recovery and precision of the method. Table 2 summarizes the results. The low recoveries found for DDD were expected since only the first fraction eluted from the Florisil column was analyzed and the DDD is known to be split between fraction one and two.[33] Only fraction one was analyzed when human milk samples were run. Since the DDD recovered on preliminary runs was less than 10 ppb, it was decided that the extra time and effort required to collect and analyzed the second fraction would not be worthwhile. We confirmed our previous result[26] that storage of samples in polyethylene bags for periods of up to three months does not introduce spurious peaks in the GLC tracings.

Multiple runs of three human milk samples were made to check the reproducibility of the method. Table 3 indicates a reproducibility of about ±10% for analyses over a four-month period, during which all the analyses of the study were carried out.

TABLE 2 PESTICIDE RECOVERY STUDIES

	Mean amt. recovered (%) (8 samples)	Standard deviation of recovery (%)
Aldrin	80	± 8
op' DDE	96	7
pp' DDE	92	6
op' DDD	61	12
pp' DDD	28	15
op' DDT	91	5
pp' DDT	96	6

One ml cow's milk-samples were spiked with the pesticides and the samples were analyzed in the same manner as the human milk samples.

TABLE 3 PESTICIDE RECOVERY REPRODUCIBILITY

Sample number	Number analyses	OP' DDE (ppb)	PP' DDE (ppb)	OP' DDT (ppb)	PP' DDT (ppb)	Total DDT* (ppb)
5	5	6 ± 1	301 ± 22	7 ± 1	63 ± 13	411 ± 36
7	5	8 ± 1	1399 ± 188	22 ± 5	324 ± 27	1907 ± 230
10	5	3 ± 0.5	78 ± 8	3 ± 0.5	36 ± 2	130 ± 11

*Total DDT is 1.11 x the concentration of both isomers of DDE plus the concentration of both isomers of DDT. Figures are means ± standard deviations.

SECTION V

RESULTS AND DISCUSSION

A total of 38 samples from black donors in rural poverty areas and 14 samples from white, urban, middle-class donors in Nashville in the summer of 1974 were analyzed. The mean total DDT concentration in the samples from blacks was 447 ppb with a standard deviation of 465 ppb. The range of concentrations was from 59 to 1900 ppb (Figure 1). The samples from the Nashvillians contained a mean total DDT concentration of 75 ppb with a standard deviation of 40 ppb. The range of concentrations was from 15 to 133 ppb (Figure 2). We had found a mean level of about 170 ppb with this population 3 years ago.[26] An additional 7 samples from the black donors taken in the summer of 1975 contained a mean total DDT concentration of 323 ppb with a standard deviation of 176 ppb (range 185-721 ppb).

The mean of the DDT concentrations found in the poverty areas in 1974 was compared with that of the samples from the Nashville area; it was found that the probability that the means differ due to chance was 8×10^{-5}. In all probability, most of this difference can be ascribed to the greater pesticide exposure of the blacks. However, other factors may be involved as well. Davies et al.[34] and Hoffman et al.[35] found significantly higher DDT concentrations in the adipose tissue of blacks than in that of whites. The results were obtained by analyzing specimens of adipose tissue from persons accidentally or violently killed. Although there were not as many samples from blacks analyzed, the samples from blacks contained over 50 percent more DDT than the samples from whites. In our study, all the samples from the rural poverty areas were from black donors, while those samples from the Nashville area were from white middle-class donors. A racial comparison of DDT concentrations in human milk could be made if samples were analysed from middle-class blacks in Nashville and whites of the same socioeconomic group as the blacks from the poverty areas; we did not have access to such samples. The probability that the difference in the means of the two sets of samples taken from the black donors in 1974 and 1975 is due to chance is 0.11. Actually, one would expect these people to exhibit DDT levels decreasing with time due to recent reductions in exposure to DDT, and this is in fact observed.

There appeared to be no correlation (correlation coefficient -0.2) between the age of the black donor and the DDT concentration. It was not possible to correlate the DDT concentrations with other variables such as diet, age of child home pesticide use, or distance of residence from farming fields because many of the questionnaires were not filled out completely.

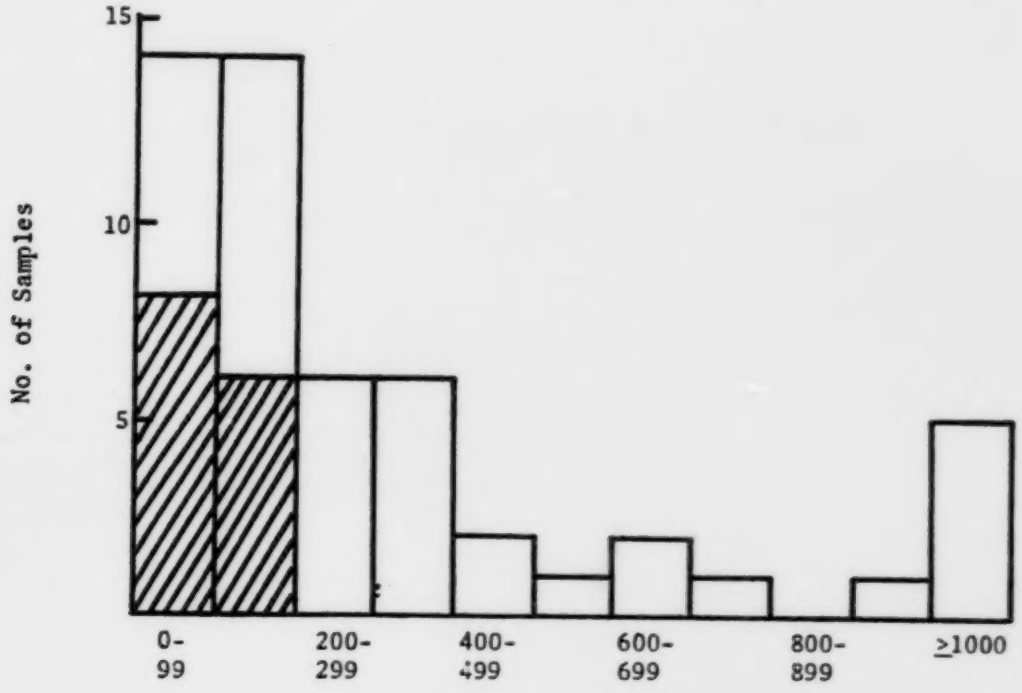
TABLE 4 DDT LEVELS IN HUMAN MILK-PRESENT STUDY

	Sample number	o,p'-DDE (ppb)	p,p'-DDE (ppb)	o,p'-DDT (ppb)	p,p'DDT (ppb)	Total DDT* (ppb)
A. Rural blacks, 1974						
	1	2	47	< 2	17	73
	2	9	276	13	89	418
	3	14	694	19	155	960
	4	8	493	16	185	757
	5	6	301	7	63	411
	6	8	182	10	77	298
	7	8	1399	22	324	1810
	8	4	191	5	84	305
	9	5	138	9	67	235
	10	3	78	3	36	129
	11	8	476	14	100	651
	12	8	1082	28	175	1413
	13	5	96	6	35	153
	14	3	49	4	26	88
	15	5	117	7	63	205
	16	4	104	6	80	206
	17	11	407	18	151	633
	18	1	52	< 2	28	89
	19	< 1	36	< 2	16	59
	20	7	225	12	38	308
	21	10	210	15	52	311
	22	8	162	10	88	287
	23	2	49	< 2	33	92
	24	4	98	< 2	43	158
	25	13	1323	25	391	1899
	26	5	167	6	105	302
	27	14	811	21	239	1176
	28	3	87	4	43	147
	29	10	397	12	82	546
	30	5	222	5	75	332
	31	3	126	< 2	28	173
	32	5	161	6	42	232
	33	< 1	107	< 2	38	160
	34	3	214	4	29	274
	35	2	63	3	23	98

TABLE 4 DDT LEVELS IN HUMAN MILK-PRESENT STUDY (Continued)

	Sample number	o,p'-DDE (ppb)	p,p'-DDE (ppb)	o,p'-DDT (ppb)	p,p'-DDT (ppb)	Total DDT* (ppb)
	36	4	146	5	45	217
	37	18	673	13	275	1055
	38	10	178	13	87	309
						447 ± 465 ppb
B. Nashville whites, 1974						
	1	3	15	< 2	7	29
	2	< 1	7	< 2	4	15
	3	4	33	6	15	62
	4	4	39	7	17	72
	5	4	32	4	13	57
	6	6	80	9	29	133
	7	7	62	12	26	115
	8	8	60	13	27	115
	9	8	59	11	22	107
	10	16	39	13	33	107
	11	< 1	15	< 2	10	30
	12	< 1	15	< 2	7	27
	13	7	24	10	16	60
	14	8	66	10	22	114
						75 ± 40 ppb
C. Rural blacks, 1975						
	1					185
	2					231
	3					280
	4					187
	5					721
	6					394
	7					264
						323 ± 176 ppb

FIGURE 1. FREQUENCY DISTRIBUTION OF TOTAL DDT LEVELS IN THE MILK OF RURAL BLACK WOMEN (UNSHADED) AND URBAN WHITE WOMEN (SHADED), 1974



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